

AMENDMENT UNDER 37 C.F.R. § 1.111
U.S. Application No.: 09/313,184

AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions and listings of claims in the application:

LISTING OF CLAIMS:

Claims 1-15 (canceled).

16. (previously presented): A sensor element comprising negative and positive electrodes disposed on the same side of a solid electrolyte substrate and a circuit for applying an electric potential between said negative electrode and said positive electrode, wherein the area of said negative electrode and the area of said positive electrode differ by at least twofold.

17. (previously presented): The sensor element as claimed in claim 16, wherein the ratio of the area of the negative electrode to the area of the positive electrode is within the range of 2:1 to 5:1, the circuit applies an electric potential of from 0.2 V to 1.1 V, and the element resistance measured between the negative and positive electrodes is from 94% to 86% of the element resistance of the same sensor except in which the negative electrode and the positive electrode have the same area.

18. (previously presented): The sensor element as claimed in claim 16, wherein the ratio of the area of the negative electrode to the area of the positive electrode is within the range of 2:1 to 5:1, the circuit applies an electric potential of from 1.1 V to 2.5 V, and the element resistance measured between the negative and positive electrodes is from 81% to 63% of the

AMENDMENT UNDER 37 C.F.R. § 1.111
U.S. Application No.: 09/313,184

element resistance of the same sensor except in which the negative electrode and the positive electrode have the same area.

19. (previously presented): The sensor element as claimed in claim 16, wherein the ratio of the area of the negative electrode to the area of the positive electrode is within the range of 1:2 to 1:5, the circuit applies an electric potential of from 0.2 V to 1.1 V, and the element resistance measured between the negative and positive electrodes is from 74% to 73% of the element resistance of the same sensor except in which the negative electrode and the positive electrode have the same area.

20. (previously presented): The sensor element as claimed in claim 16, wherein the ratio of the area of the negative electrode to the area of the positive electrode is within the range of 1:2 to 1:5, the circuit applies an electric potential of from 1.1 V to 2.5 V, and the element resistance measured between the negative and positive electrodes is from 90% to 82% of the element resistance of the same sensor except in which the negative electrode and the positive electrode have the same area.

21. (canceled).

22. (previously presented): The sensor as claimed in claim 16, wherein said solid electrolyte substrate comprises zirconia.

23. (previously presented): The sensor as claimed in claim 16, wherein the negative and positive electrodes comprise porous platinum.

AMENDMENT UNDER 37 C.F.R. § 1.111
U.S. Application No.: 09/313,184

24. (previously presented): A flat current-limiting sensor comprising a sensor element according to claim 16.

Claims 25-29 (canceled).

30. (previously presented): A sensor for detecting an amount of a gas, comprising an oxygen-ion conductive solid electrolyte substrate having a flat side, a negative electrode and a positive electrode formed on the same flat side of the substrate so as to pump oxygen from the negative electrode to the positive electrode, and a gas diffusion limiting means for limiting the gas diffusing into the negative electrode,

wherein the ratio of the area of said negative electrode to the area of said positive electrode is set within a range of 2:1 to 5:1, and

said sensor comprising a circuit for applying an electric potential between said negative and positive electrodes such that a pump current flows between the negative and positive electrodes when the sensor is used for detecting the amount of a gas, said pump current being a measurement of the amount of gas.

31. (previously presented): A sensor for detecting an amount of a gas, comprising an oxygen-ion conductive solid electrolyte substrate having a flat side, a negative electrode and a positive electrode formed on the same flat side of the substrate so as to pump oxygen from the negative electrode to the positive electrode, and a gas diffusion limiting means for limiting the gas diffusing into the negative electrode,

AMENDMENT UNDER 37 C.F.R. § 1.111
U.S. Application No.: 09/313,184

wherein the ratio of the area of said negative electrode to the area of said positive electrode is set within a range of 1:2 to 1:5, and

 said sensor comprising a circuit for applying an electric potential between said negative and positive electrodes such that a pump current flows between the negative and positive electrodes when the sensor is used to detect the amount of a gas, said pump current being a measurement of the amount of gas.

32. (previously presented): An oxygen sensor for determining the oxygen concentration of a gas, comprising first and second chambers (62, 64) formed between first and second oxygen ion conductive cell substrates (66, 68) and first and second electrodes (68a, 68b) formed on the same plane of the second cell substrate (68), said first electrode (68a) being formed on an inside wall of the second chamber (64) and said second electrode (68b) being formed outside of the second chamber (64),

 wherein the area of the first electrode is at least twofold larger than that of the second electrode, and

 the sensor comprises means for applying an electric potential in the range of 0.2 V to 1.1 V between the first and second electrodes such that a pump current flows between the first and second electrodes when the sensor is used to determine the concentration of oxygen in a gas, said pump current being a measurement of oxygen concentration.

33. (currently amended): A humidity sensor for determining the humidity of a gas, comprising first and second chambers (62, 64) formed between first and second oxygen ion conductive cell substrates (66, 68) and first and second electrodes (68a, 68b) formed on the same

AMENDMENT UNDER 37 C.F.R. § 1.111
U.S. Application No.: 09/313,184

plane of the second cell substrate (68), said first electrode (68a) being formed on an inside wall of the second chamber (64) and said second electrode (68b) being formed outside of the second chamber (64),

wherein the area of the first electrode is at least twofold larger than that of the second electrode, and

the sensor comprises means for applying an electric potential in the range of 1.1 V to 2.5 V between the first and second electrodes such that a pump current flows between the first and second electrodes when the sensor is used to determine the humidity of a gas, said pump current being a measurement of humidity.

34. (previously presented): An oxygen sensor for determining the oxygen concentration as a component of a gas containing NO_x, comprising first and second chambers (62, 64) formed between first and second oxygen ion cell substrates (66, 68) and first and second electrodes (68a, 68b) formed on the same plane of the second cell substrate (68), said first electrode (68a) being formed on an inside wall of the second chamber (64) and said second electrode (68b) being outside of the second chamber (64),

wherein the area of the first electrode is at least twofold larger than that of the second electrode, and

the sensor comprises means for applying an electric potential in the range of 0.2 V to less than 0.5 V such that a pump current flows between the first and second electrodes when the sensor is used to determine oxygen concentration as a component of a gas containing NO_x, said pump current being a measurement of oxygen concentration.

AMENDMENT UNDER 37 C.F.R. § 1.111
U.S. Application No.: 09/313,184

35. (currently amended): The oxygen sensor as claimed in claim 34, comprising a circuit for applying an electric potential in the range of 0.2 V to less than 0.5 V such that wherein a pump current of less than 10 microamperes flows between the first and second electrodes when the sensor is used to determine oxygen concentration as a component of a gas containing NO_x, said pump current being a measurement of oxygen concentration an electric potential in the range of 0.2 V to less than 0.5 V is applied across the first and second electrodes.

36. (currently amended): A sensor for detecting the amount of a gas, comprising:

a first oxygen ion pump cell (66), an oxygen-concentration-measuring cell (67), and a second oxygen ion pump cell (68), which are sequentially arranged in layers over each other;

the first oxygen ion pump cell (66) including a first solid electrolyte layer and electrodes (66a) and (66b) provided on opposite sides of the first solid electrolyte layer;

the oxygen-concentration-measuring cell (67) including a second solid electrolyte layer and oxygen partial-pressure detection electrodes (67a) and (67b) provided on opposite sides of the second solid electrolyte layer;

the second oxygen ion pump cell (68) including a third oxygen ion conductive solid electrolyte layer and oxygen pump electrodes (68a) and (68b) provided on the same side of the third oxygen ion conductive solid electrolyte layer;

a first measurement chamber (62) defined by the first oxygen ion pump cell (66);

a second measurement chamber (64) defined by the second oxygen ion pump cell (68);

AMENDMENT UNDER 37 C.F.R. § 1.111
U.S. Application No.: 09/313,184

first and second diffusion holes (61) and (63) located apart from one another and serving as serial passageways for transmission of measurement gas from outside of the sensor toward the electrode (68a) via diffusion resistance,

said second diffusion hole (63) extending through the oxygen-concentration-measuring cell (67) and the second solid electrolyte layer to establish communication between the first and second measurement chambers (62) and (64); and

said oxygen ion pump electrodes (68a) and (68b) differing in area by at least twofold.

Please add the following new claim:

37. (new) A sensor element (20) comprising a first solid electrolyte substrate (22), a second solid electrolyte substrate (24) and a negative electrode (34a) and positive electrode (32a) sandwiched between said first and second solid electrolyte substrates, said negative and positive electrodes being disposed on the same side of said first solid electrolyte substrate (22), the sensor element further comprising a gas diffusion portion (34c) for introducing a gas to be measured into the negative electrode (34a) and a gas outlet hole (26) formed through the second solid electrolyte substrate (24) so as to expose a portion of the positive electrode (32a) allowing oxygen to be released from the positive electrode (32a) to an exterior of the sensor element (20).